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GB 2135136 A GB 1261122 A GB 1131142 A
GB 1032851 A GB 0645785 A EP 0454405 A
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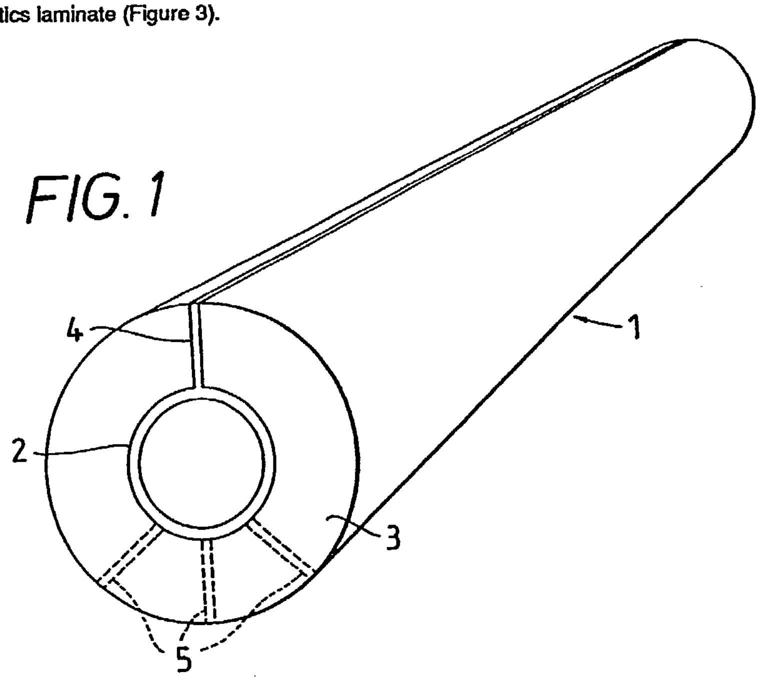
(54) Duct for receiving an optical fibre member

(57) A duct for receiving an optical fibre member has a radially inner layer (2) which defines the inside wall of the duct and which is electrically conductive. The duct has means (4, 5) defining the path for electrical charge to travel from the inner layer to the exterior of the duct. The conductive inner layer may be a polymer with conductive material dispersed therein e.g. C black or fibres, Al flakes, Cu fibres; or a conductive polymer. The outer layer (3) may be mineral filled polyethylene modified with vinyl acetate. The conductive path may be provided by a castellated structure (Fig 2) or the exposed edge of a tube of metal/plastics laminate (Figure 3).

FIG. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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FIG. 1

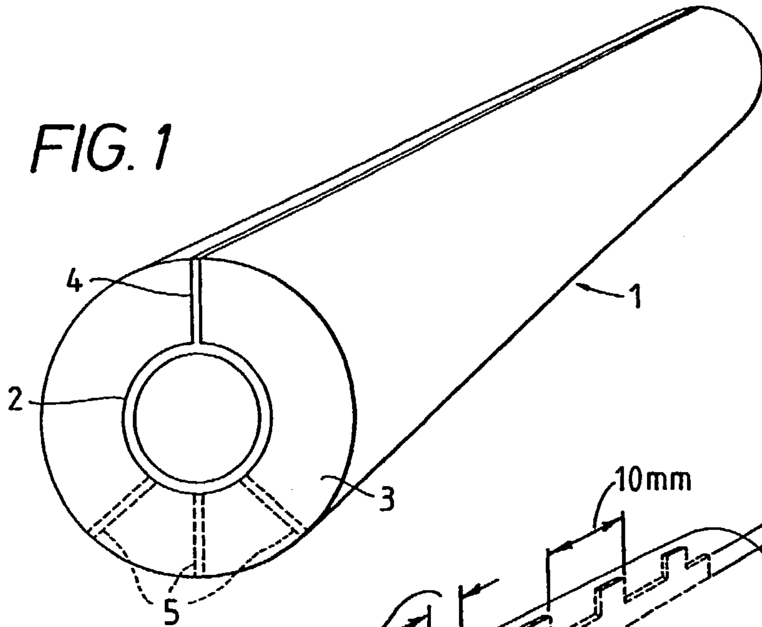


FIG. 2

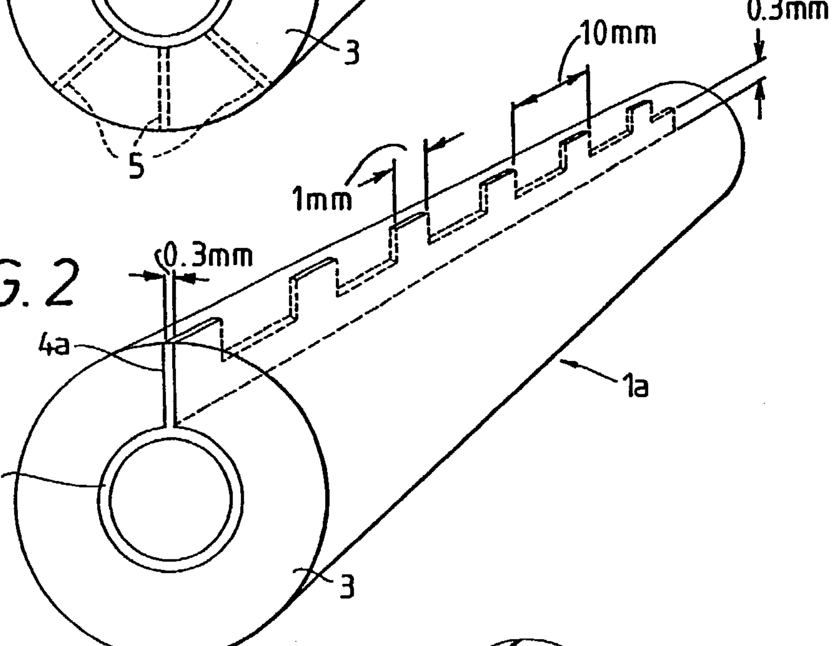
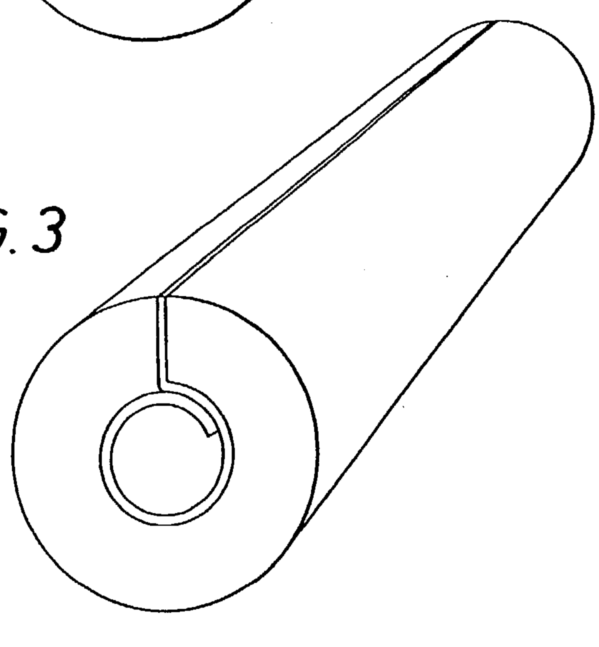


FIG. 3



DUCT FOR RECEIVING AN OPTICAL FIBRE MEMBER

This invention relates to a duct for receiving an optical fibre member. The term "optical fibre member" is used herein to cover both members which contain a single optical fibre and members which contain a plurality of optical fibres, and it is to be understood that the duct described herein can be used to receive either a single optical fibre member or a plurality of optical fibre members, and in the latter case the plurality of optical fibre members may be installed simultaneously or successively.

The present invention is more particularly concerned with a duct in which one or more optical fibre members are to be installed using a flowing fluid. Such a technique is described, for example, in EP-A-108590, and is referred to for convenience herein as the installation of optical fibre members by blowing. It is to be understood, however, that the flow of installation fluid, which is preferably air or some other suitable gas, could be produced by sucking, either in addition to, or instead, of blowing.

The ducts hitherto used for the installation of fibres by blowing have been made of plastics materials. It has been found that during the installation of an

optical fibre member by blowing, a static electrical charge builds up on the inside wall of the duct, which then attracts the optical fibre member and impedes its progress. This is a variable phenomenon, depending on the particular combination of materials and on environmental conditions. Given time, the static charge will dissipate itself, but it is not normally practical to slow or to stop the installation process, perhaps several times, to allow this to happen.

Mobile additives have been incorporated in the duct material with a view to reducing friction between the optical fibre members and the duct. These do in fact help to dissipate static electrical charge, though they were not proposed for this purpose. However, they are by no means ideal for this purpose. For one thing, the way these additives work is that they migrate to the surface of the duct, and this takes time. Furthermore, once there they are gradually removed by abrasion and other effects, such as washing, and so the effect of the additive in dissipating static electrical charge is gradually reduced. Also, the effectiveness of these additives can depend on the amount of atmospheric humidity.

Attention is also directed to WO90/00823 which proposes a duct having two concentric layers, the inner layer

comprising, for example carbon doped high density polyethylene. Although proposed for the purpose of reducing friction between the optical fibre members and the duct the electrical conductivity of the carbon does in fact help to dissipate static electrical charge. This effect is not disclosed in WO90/00823.

Finally, attention is directed to EP-A-454405, which provides, inter alia, a duct for receiving an optical fibre member, which duct is formed at least in part of a plastics material which is electrically conductive or has an electrically conductive material held therein.

Although the duct described in EP-A-454405 represents a significant advance over the prior art in terms of dissipation of static electrical charge, its ability to dissipate charge is nevertheless somewhat limited. It is an object of the present invention to effect an improvement in this.

According to the present invention there is provided a duct for receiving an optical fibre member, which duct has a radially inner layer which defines the inside wall of the duct and which is electrically conductive, the duct having means defining a path for electrical charge to travel from the inner layer to the exterior of the duct.

Figures 1, 2 and 3 of the accompanying drawings show three embodiments of the invention, in diagrammatic perspective views.

The embodiment of Figure 1 is a duct 1 having an inner layer 2 which is electrically conductive. The inner wall of the inner layer 2 defines the bore of the duct. The layer 2 is surrounded almost completely by an outer layer 3 which is electrically non-conductive.

At least at one location, however, the inner layer 2 is not surrounded by the outer layer 3, which is where the inner layer is connected to the exterior surface of the duct by an electrically conductive strip 4. This is shown as being a continuous strip extending the whole length of the duct, but it would be possible instead for the duct to be provided with a plurality of shorter strips separated longitudinally from one another. Also one or more additional conductive strips 5 may be provided as indicated in broken lines (or one or more additional sets of shorter strips). The presence of the strip or strips 4, and optionally the strip or strips 5, means that charge arising on the layer 2 will flow to the exterior surface the duct. This itself is an advantage since the charge then resides on the exterior of the duct instead of on the exterior surface

of the layer 2, and this is further from the bore of the duct and so less able to affect a fibre travelling in the bore of the duct. However, an additional advantage is obtained if the exterior surface of the duct is earthed, since the charge is then conducted away from the duct completely. A further advantage is obtained if the exterior surface is continuously connected, or has multiple connections, to earth, since the rate at which charge is conducted away is increased.

If desired, a plurality of ducts may be joined end-to-end to form a continuous passageway for installation of an optical fibre member, in which case the external surfaces of the ducts are preferably electrically connected to one another so that charge can flow from one duct to the next and thus improve charge dissipation. If this is done, all the ducts can be earthed by connecting a single one of them to earth.

In choosing a conductive material for the inner layer 2, it is desirable that it should have a high conductivity and a short charge decay time. Charge decay time may be measured by one of a number of standard tests. Two of these are referred to below. The first is a British Standard (BS 2782, Part 2, Method 250A: 1976 "Antistatic behaviour of film: charge

decay method"), which measures the time taken for the charge on a surface to fall to half its initial value. The second is a U.S. standard (Federal Test Method 101-4046), in which the time is measured for the potential on a surface to fall from 5kV to 50 volts. Preferably, the conductive material used in the present invention should have a charge decay time, as measured by BS 2782, of not more than 10 seconds, more preferably not more than 1 second, and most preferably not more than 0.1 second. As measured by the above U.S. standard, the corresponding times are approximately seven times as long as those measured by BS 2782.

The inner layer 2 may be formed of a plastics material having an electrically conductive material held therein. The conductive material is preferably carbon black. The particles of carbon black preferably have a high surface area:volume ratio. The carbon black is preferably present in an amount of at least 2%, more preferably at least 10%, by weight, based on the total weight of plastics material and carbon black. The amount of carbon black may be as much as 50% or even more. One form of carbon black which can desirably be used is acetylene black, for example in an amount of about 25% by weight, based on the total weight of plastics material and carbon black. Alternatively, metallic particles can be used (e.g. aluminium flakes

or particles of Zelec, a material described below), electrically conductive fibres (e.g. chopped carbon fibres), or chopped metallic wire, (e.g. copper wire). If desired, longer lengths of such fibre or wire can be incorporated in addition.

The plastics material is preferably a high density polyethylene, though a low or medium density polyethylene may alternatively be used, or polypropylene, for example.

Alternatively, the inner layer 2 may be formed of a plastics material which is itself conductive, for example, a material selected from the following: polyaniline, polyacetylene, polypyrole, polyphthalocyanine and polythiophene. The conductive plastics material may be used alone or blended with a non-conductive plastics material, for example polyethylene or polypropylene.

The outer layer of the duct may, for example, be formed from a mineral-filled thermoplastic sold as MEGOLON S300 by Lindsay and Williams Ltd of Ogden Lane Works, Columbine St, Manchester, England. MEGOLON S300 is a polyethylene modified with vinyl acetate and containing mineral additives (in fact, hydrated metal fillers) to give it flame-retardant and low smoke/low fume

characteristics. Alternative materials for the outer layer include cable grade polyethylene and metal. The use of a two-layer duct makes it possible to select for the inner layer a material which has optimum properties for blowing, e.g. a low coefficient of friction, a smooth surface finish and a substantial ability to dissipate static electricity, whilst having an outer layer which has the desired properties in terms of mechanical strength, resistance to environmental attack, fire resistance, external diameter, burst strength and so forth. If all the desired properties for the outer layer cannot be achieved using a single material it may be preferred to have a plurality of layers outside the inner layer, instead of just a single outer layer.

A typical two-layer duct of the type just described has an internal diameter of 3.5mm, an inner layer having a wall thickness of 0.15 mm and an outer layer having an external diameter of 5.0 mm. More generally, the internal diameter of the duct is preferably from 1 mm to 10 mm.

The two-layer duct can be produced by simultaneously extruding the two layers from two extruders through concentric annular dies, and causing the two layers to unite before they solidify. Alternatively the duct can

be produced by simultaneously but separately extruding the two layers 2 and 3 and the strip 4 from three extruders, each containing different materials, to ensure the optimum balance of physical and dissipative properties as the layers and strip unite before they solidify.

A further alternative form of duct can be produced by simultaneously extruding the two layers around a pre-formed strip causing the two layers and the strip to unite before the whole cross section solidifies. The pre-formed strip may be formed from the range of materials given as examples for the inner layer or alternatively may be a metallic conductor in the form of a solid strip, a notched or castellated strip, or a braided wire strip or a braided carbon fibre strip, with or without a laminated plastic covering, which may be conductive, to further aid the uniting of all the materials before they solidify. The notched, castellated or braided strip allows the strip to be encapsulated by the outer layer material aiding the integrity of the whole, while preserving flexibility.

Figure 2 shows an example of what is referred to above as a duct with a castellated strip. The duct is denoted by reference numeral 1a and the strip by reference numeral 4a.

Yet another alternative possibility for forming the two layer duct is to line a non-conductive plastics duct with a conductive film. One such film is a polyester film which has been rendered conductive by coating it with a material sold under the name of Zelec ECP-S by E.I. du Pont de Nemours & Co. of Wilmington, Delaware, U.S.A., Zelec ACP-S is available as a powder in which particles of a chemically inert material, for example silica, titanium dioxide or mica, are coated with antimony-doped tin oxide. The coated film has a typical surface resistance of 1.6 x 10^6 ohms/square and a typical charge decay time of 0.01 seconds, as measured by Federal Test Method 101-4046.

Another conductive film which can be used is a plastics/aluminium laminate. Yet another possibility is to coat a plastics duct internally with a metal film, which may have been surface treated (for example by electron beam irradiation) to aid the uniting of the materials before they solidify.

Examples of ducts according to the invention will now be given:

Example 1

The inner layer 2 is formed of high density

polyethylene having carbon black dispersed therein. One suitable material is that formed from a resin sold as CABELEC 3172 and available from Cabot Plastics Limited of Gate Street, Dukinfield, Cheshire, England. The outer layer 3 is formed from a mineral-filled thermoplastic sold as MEGOLON S300 by Lindsay and Williams Ltd of Ogden Lane Works, Columbine St, Manchester, England. CABELEC 3172 consists of carbon black dispersed in a high density polyethylene and has a typical volume resistivity of 10^3 ohm. cm, a typical surface resistivity of 10 ohms/sq, and a charge decay time of much less than 0.1 second. The duct has an internal diameter of 3.5 mm, the inner layer is 0.15 mm thick, and the external diameter of the outer layer is 5.0 mm. The duct has a radial conductive strip 4, as shown in Figure 1 formed of the resin CABELEC 3172.

Example 2

This duct is the same as that of Example 1, except that the duct has a radial conductive castellated strip 41, as shown in Figure 2, formed of 100% IACS (International Ampere Current Standard) annealed copper, extending so as to connect the inner layer 2 to the outer surface.

Example 3

This duct is the same as that of Example 1 except that

instead of CABELEC 3172 the resin used is PE 2573, also available from Cabot Plastics Limited. This consists of carbon black dispersed in low density polyethylene. It has a typical volume resistivity of 10^2 ohm. cm, a surface resistivity of less than 250 ohms/sq and a charge decay time of much less than 0.1 second.

Example 4

A duct of the same internal and external diameters as in Example 1 is formed using a polyethylene/aluminium film as the inner layer 2 to provide electrical conductivity. The film comprises a layer of aluminium 0.15mm thick laminated to a layer of conductive polyethylene 0.04mm thick. The film laminate is formed into a tube with the aluminium layer on the inside. Equipment for forming a film laminate into a tube is well known in the cable-making industry and is therefore not described further here. As the tube is formed it is oversheathed by simultaneously but separately extruding the outer layer and strip to give a duct of the desired dimensions.

Example 5

A duct is formed by the same method as in Example 4, but using a Zelec-coated polyester film, as described above, coated over the whole of its surface, including the edges, in place of the polyethylene/aluminium

laminate.

Example 6

A duct of the same internal and external diameters as in Example 1 is formed using a polyethylene/aluminium film as a single material to provide electrical conductivity from the inner surface to the outer surface. The film comprises a layer of aluminium 0.15 mm thick laminated to a layer of polyethylene 0.04 mm thick, slit to the required width prior to forming so as to expose the aluminium at its edges. The film laminate is formed into the shape of a tube with integral strip as shown in Figure 3, with the aluminium layer on the inside of the tube. As the tube and strip are formed, they are oversheathed with extruded plastic to form the outer layer and give a duct of the desired dimensions.

CLAIMS:

1. A duct for receiving an optical fibre member, which duct has a radially inner layer which defines the inside wall of the duct and which is electrically conductive, the duct having means defining a path for electrical charge to travel from the inner layer to the exterior of the duct.

2. A duct as claimed in claim 1, having at least one further layer positioned outwardly of the said inner layer, the inner layer being formed of a material which is electrically conductive or has electrically conductive material held therein or applied thereto, the said path for electrical charge passing through the said further layer.

3. A duct as claimed in claim 2, wherein the said layers are co-extruded layers.

4. A duct as claimed in claim 2, wherein the inner layer comprises a conductive film.

5. A duct as claimed in claim 4, wherein the conductive film is a plastics/metal laminate.

6. A duct as claimed in claim 5, wherein the laminate is a polyethylene/aluminium laminate.

7. A duct as claimed in claim 4, wherein the conductive film is a metal film.

8. A duct as claimed in any one of claims 4 to 7, wherein the said conductive film also forms the said path.

9. A duct according to any one of claims 1 to 3, wherein the said inner layer is formed at least in part of a plastics material which has an electrically conductive material held therein.

10. A duct according to claim 9, wherein the said electrically conductive material is carbon black.

11. A duct according to claim 10, wherein the carbon black is present in an amount of at least 2% by weight based on the total weight of the carbon black and the plastics material in which it is held.

12. A duct according to claim 11, wherein the carbon black is present in an amount of at least 10% by weight.

13. A duct according to claim 10, wherein the carbon black is acetylene black.

14. A duct according to claim 13, wherein the acetylene black is present in an amount of about 25% by weight based on the total weight of the carbon black and the plastics material in which it is held.

15. A duct according to any one of claims 1 to 3, wherein the said inner layer is formed at least in part of a plastics material which has held therein, as an electrically conductive material, a material selected from the group consisting of metallic particles, electrically conductive fibres, for example chopped carbon fibres, and chopped metallic wire.

16. A duct according to any one of claims 1 and 3, wherein the said inner layer is formed at least in part of a plastics material which is electrically conductive and which is selected from the group consisting of polyaniline, polyacetylene, polypyrole, polyphthalocyanine and polythiophene.

17. A duct according to any preceding claim, which comprises polyethylene or polypropylene.

18. A duct according to any preceding claim, wherein

the means defining the said path comprises at least one strip extending radially from the said inner layer to the exterior of the duct.

19. A duct according to claim 18, wherein the or each said strip is castellated at its radially outer edge.

20. A duct according to any preceding claim, wherein the means defining the said path comprises a plurality of conducting members spaced longitudinally from one another.

21. A duct according to any preceding claim, wherein the radially inner layer is made of a material which has a charge decay time, as measured by BS 2782. of not more than 10 seconds.

22. A duct according to claim 21, wherein the said charge decay time is not more than 1 second.

23. A duct according to claim 22, wherein the said charge decay time is not more than 0.1 second.

24. A duct according to any one of claims 1 to 20, wherein the radially inner layer is made of a material with which the time measured by U.S. Federal Test Method 101-4046, for the potential on a surface to fall

from 5kV to 50 volts is not more than 70 seconds.

25. A duct according to claim 24, wherein the said time is not more than 7 seconds.

26. A duct according to claim 25, wherein the said time is not more than 0.7 seconds.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) G02B (6/44)

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

MR J L FREEMAN

Date of Search

21 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1 TO 26

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2135136 A (WAVIN B.V.) page 4 lines 7 to 12	1,2,9 and 10
X	GB 1261122 A (W A PLUMMER) figure 1	1 and 2
X	GB 1131142 A (R C MILDNER) figures 4 and 5	1,2 and 4 to 8
X	GB 1032851 A (FLEXADUX) page 2 lines 44 to 64	1,2,9 and 15
X	GB 645785 A (R G GRUBB & S W M MORRIS) page 1 line 59 and page 2 lines 39 to 64	1 and 2
XP	EP 0454405 A (BICC) whole document	1 to 26
X	WO 90/00823 A (BRITISH TELECOM) page 2 paragraph 6	1,2,3,9 and 17

SF2(p) ME - doc99\fil000408

Category	Identity of document and relevant passages	Rele .t to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

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